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CONTENTS

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SCIENCE AND MEDICAL TEACHING[1]

PRESIDENT ELIOT, through the long years of his distinguished service, has begged for a larger cultivation of the sciences among our people and only recently he has demanded that such a wider tuition be introduced into our schools as a necessity of proper national reconstruction. The value of science to mankind is being everywhere more fully appreciated. It is of its prophets in the past that this paper is to deal.

In the preface to the fourth edition of Lavoisier's "Elements of Chemistry," as translated from the original French and printed in Philadelphia in 1799, one finds the following conception of the scientific method.

> When we begin the study of any science, we are in a situation, respecting that science, similar to children; and the course by which we have to advance is precisely the same which Nature follows in the formation of their ideas. In a child, the idea is merely an effect produced by a sensation; and, in the same manner, in commencing the study of a physical science, we ought to form no idea but what is a necessary consequence, and immediate effect, of an experiment or observation. Besides, he who enters upon the career of science, is in a less advantageous situation than a child who is acquiring his first ideas. To the child, Nature gives various means of rectifying any mistakes he may commit respecting the salutary or hurtful qualities of the objects which surround him. On every occasion his judgments are corrected by experience; want and pain are the necessary consequences arising from false judgment; gratification and pleasure are produced by judging aright. Under such masters, we can not fail to become well informed; and we soon learn to reason justly, when want and pain are the necessary consequences of a contrary conduct.
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> In the study and practise of the sciences it is entirely different; the false judgments we may

[1] Address at the meeting for the award of honors to students of medicine of Harvard University, December 16, 1918.

form neither affect our existence nor our welfare; and we are not compelled by any physical necessity to correct them. Imagination, on the contrary, which is ever wandering beyond the bounds of truth, joined to self-love and that self-confidence we are so apt to indulge, prompt us to draw conclusions which are not immediately derived from facts; so that we become in some measure interested in deceiving ourselves. Hence it is by no means surprising, that, in the science of physics in general, men have so often formed suppositions, instead of drawing conclusions. These suppositions, handed down from one age to another, acquire additional weight from the authorities by which they are supported, till at last they are received, even by men of genius, as fundamental truths.

The only method of preventing such errors from taking place, and of correcting them when formed, is to restrain and simplify our reasoning as much as possible. This depends entirely on ourselves, and the neglect of it is the only source of our mistakes. We must trust to nothing but facts: These are presented to us by Nature, and can not deceive. We ought, in every instance, to submit our reasoning to the test of experiment, and never to search for truth, but by the natural road of experiment and observation.

Thoroughly convinced of these truths, I have imposed upon myself, as a law, never to advance but from what is known to what is unknown; never to form any conclusion which is not an immediate consequence necessarily flowing from observation and experiment.

Such, then, were the principles of this great master scientist of France as he wrote them a hundred and twenty-five years ago. And yet they seem vibrant with the teachings of our own day and generation. Perhaps it may be of interest to examine the growth of this modern mental attitude, especially in its relation to medicine.

The universities of Cambridge (founded in 1229) and Oxford (founded in 1249) were established at a time when authority was worshipped. It was not until after the revival of learning in Italy that the original versions of the ancient classics of Greece and Rome were brought to these English universities, there to be studied at first hand and the unknown culture of a bygone civilization revealed. In this way it was learned, for example, that Hippocrates (circa B.C. 430) had been misquoted by Galen, for the Father of Medicine in truth had remarked:

Whoever having undertaken to speak and write on medicine have first laid down for themselves some hypothesis to their argument such as hot or cold or moist or dry or whatever else they choose (thus reducing their subject within a narrow compass and supposing only one or two original causes of disease or of death among mankind) are clearly mistaken in much that they say.

This was a far more liberal doctrine than the interpretation of Galen († A.D. 200) who, in his medical definitions, says: "The elements of medicine, as some of the ancients thought, are hot and cold, moist and dry" and "Of what do our material bodies consist? Of the four elements, fire, air, earth and water."

So from this ancient fount of information Chaucer's doctor knew the causes of diseases:

He knew the cause of every malady
Were it of cold or hot or moist or dry
And where engendered and of what humour,
He was a very perfect practisour.

It is evident that the revival of learning in the fifteenth and sixteenth centuries, with its scholarly search through the buried classics, must have had a profound influence upon men's minds in its revelation of the forgotten past. That the elements of Empedocles, fire, air, earth and water, should have been the accepted basis of the chemical world for nearly two thousand years seems incredible to the modern mind. And yet, when one considers the past, one is forced to the conviction that the general adoption of revolutionary principles, as lately carried out in Russia, might once again reduce the world to the condition in which it existed during the Dark Ages. And one might conceive that a European or an American a hundred years hence might have to travel to Tokio in order to find a copy of the *Journal of Biological Chemistry*.

Galileo was born in 1564 and was the first great modern scientist who chose to trust his own observations rather than accept the teachings of authorities. In 1633 he was forced by

the Inquisition to renounce his teachings. This was five years after the publication of Harvey's discovery of the circulation of the blood, which the intellectual world received with merciless criticism as being contrary to the doctrines of Galen. These were also the days of the Thirty Years War in Germany, a war of religious intolerance.

In 1651 Harvey published his "De Generatione," which was the finest piece of observation and analysis of his day. In 1656 he transferred property to his college which yielded an income of fifty-six pounds to be used as a salary for a librarian and to found an annual oration the object of which was "to search out and study the secrets of nature by way of experiment."

In 1660 the Royal Society of London was founded, the progenitor of which was the Royal Society Club, the oldest club in Europe. This latter was made up of men who clubbed together and ate their meals at a tavern, and the club still continues to dine weekly in London, drinking three toasts, "The King," "The Arts and Sciences" and "The Royal Society."

In Robert Boyle's "Hydrostatical Paradoxes," printed at Oxford in 1666, the preface begins:

> The Rise of the following Treatise being a Command imposed on me by the Royal Society.

Instead of being persecuted as Harvey had been, Boyle had the support of his friends of the Royal Society. On the last page of Boyle's volume he describes a biological experiment in which he had placed a tadpole under pressure equal to that of a column of water between two or three hundred feet high and concludes as follows:

> And yet all this weight being unable to oppress, or so much as manifestly to hurt, the tender Tadpole (which a very small weight would suffice to have crushed if it prest only upon one part of it and not on the other) we may thence learn the Truth of what we have been endeavoring to evince: That though water be allowed to press against water and all immersed Bodys; yet a Diver may well remain unoppressed at a great depth under water as long as the pressure of it is uniform against all the parts exposed thereunto.

We learn from this application of the Law of Pascal ("the ingenious Monsieur Pascal," Boyle calls him) how quickly the age of historical research liberated the mind so that an age of experimental observation set in.

Another hundred years roll around and bring to us the eccentric Cavendish, who discovered hydrogen and who was also a faithful attendant of the Royal Society; and Lavoisier, the master scientist of France; and our own Benjamin Franklin and Benjamin Thompson, the latter also known as Count Rumford.

Although the first half of the last century was a brilliant era in French science, it was not until about 1850 that Germany fully dissociated science from speculative philosophy and entered the field of scientific progress. Liebig, a pupil of Gay-Lussac, brought into Germany from Paris the knowledge of chemistry as it had been expounded by Lavoisier and Berthollet. It should be remembered that in the Middle Ages until 1618 Germany was a land of peaceful traders and there arose important cities, such as Augsburg and Nuremburg. In the latter city Hans Sachs had composed 6,000 pieces of poetry and Dürer had painted his wonderful masterpieces. It was a time of prosperity and cultivation, in evidence of which free public baths were being introduced into the cities in imitation of the Roman establishments. Then came the Thirty Years War, between 1618 and 1648, which is said to have reduced the population of Germany from 30,000,000 to 5,000,000 inhabitants. This war, carried on between Protestants and Catholics, brought abject poverty to the people, who reverted well nigh into barbarism. Germany was in this condition at the time of the founding of the Royal Society of London. Leibniz, who had visited Paris and London, was the founder and first president of the Academy of Sciences at Berlin which dates from the year 1700.

It is interesting to note that the town of Munich was put in orderly condition by Benjamin Thompson, who was born in the neighborhood of Concord, New Hampshire. Thompson, who was created Count Rumford, was a scientist of distinction and his work upon heat

is acknowledged to be accurate and true. He exercised great influence in the kingdom of Bavaria and especially in the town of Munich. He found the soldiers indolent and he put them to work upon the land, thereby increasing the food supply. He studied the principles of stoves so that cooking might be done in the most economical manner. In 1790 he caused the soldiers to arrest within one week 2,600 beggars and vagabonds, who were also potential thieves, and put them to work, directing that it all be done in a kindly manner. This large number of indigents came from a total population of 60,000. Soup kitchens were provided and a soup made of bones and blood, the cheapest slaughter-house materials, was furnished for these workers. In this way he completely abolished poverty. The beautifully planned English Garden in Munich is another evidence of Count Rumford's capacity. This is a historical example of a distinguished scientific man in complete charge of a government. It finds a modern counterpart in the control of the Panama Canal Zone by General Gorgas.

The marvelous growth of German science since 1850 has been the admiration of the world. To the severely critical it may possibly seem to have passed through two stages; a first stage, that of the study of science for the love of finding out the truth, and a second stage, the study of science, because, as a German professor once wrote me, "pride in a scientific reputation as an incentive to ambition is not to be underestimated." One may also point out that no other nation more completely adopted the doctrines of Darwin, and that Koch continued the brilliant lead of Pasteur.

The other day, when speaking to my students of the work of Otto Neubauer upon the method of the deamination of amino-acids within the body, I called attention to the fact that this fine piece of work was not done in a chemical nor yet in a physiological institute but in the laboratory of the second medical clinic of Friedrich Müller in the town of Munich; that though we could celebrate with joy our victories over that vicious symposium of evil known as Prussian militarism, the leaders of which in cowardly manner have slunk out of harm's way, yet it would be unworthy of us if we could not continue to celebrate German triumphs of peaceful, scientific achievement.

About ten years ago I was in Berlin and heard bitter complaint that there was no money for new hospital buildings, no money for new laboratories, and all this because the Kaiser must have money for his new toys, battleships which were to be constructed. To-day, where are those battleships? Gone. Gone, also, the Kaiser. But the Charité Hospital in Berlin, with all that it has stood for in the history of medicine, still stands. Its past, at least, will endure and we have no right to wish anything for it but an equally brilliant future.

For the moment let us remember Longfellow's poem on Nuremburg:

Vanished is the ancient splendor, and before my dreamy eye
Wave these mingled shapes and figures, like a faded tapestry.
Not thy Councils, not thy Kaisers, win for thee the world's regard;
But thy painter, Albrecht Dürer, and Hans Sachs thy cobbler-bard.

There is only one thing that would be more stupid than our failure to recognize the importance of German scientific achievement and that would be that the Germans, having suffered disastrous and fitting punishment for the evil of their ways, should decide to exclude the thoughts and ideas, whether of morals, of art or of science, of those with whom they had lately been at war.

In the field of hospital nursing American institutions have long been preeminent. As a nation we have developed the quality of mercy to a high degree. This quality of mercy has been distinctly lacking in both the German character as well as in the administration of very many of their hospitals. But this quality of mercy is not the whole equipment of a modern physician, else the trained nurse or the Christian Science reader would be all-sufficient for assuaging the physical woes of mankind. Very much more than this is demanded of the physician, who has to interpret the derangements of the human body and attempt a recon-

structive program. This knowledge can be obtained only from the biological sciences as applied to medicine.

It is interesting to follow the teachings of the brilliant school of French scientists which made Paris the rendezvous of the illustrious men of the continent. Lavoisier, in his "Elements of Chemistry," quotes the then recently deceased French philosopher, the Abbé de Condillac as follows:

> Instead of applying observation to the things we wished to know, we have chosen rather to imagine them. Advancing from one ill-founded supposition to another, we have at last bewildered ourselves amid a multitude of errors. These errors, becoming prejudices, are, of course, adopted as principles, and we thus bewilder ourselves more and more. The method, too, by which we conduct our reasonings is absurd. We abuse words which we do not understand, and call this the art of reasoning. When matters have been brought this length, when errors have been thus accumulated, there is but one remedy, by which order can be restored to the faculty of thinking; this is, to forget all that we have learned, to trace back our ideas to their source, to follow the train in which they rise, and, as Lord Bacon says, to frame the human understanding anew.

It is readily seen that such a standpoint as this, as well as that developed by Lavoisier and quoted at the beginning of this paper, would affect the ideas of thoughtful medical men. The French physiologist Magendie, who lived a generation later than Lavoisier and who was the founder of experimental physiology, wrote in 1836 in his "Elements of Physiology" the following words:

> In a few years physiology, which is already allied with the physical sciences, will not be able to advance one particle without their aid. Physiology will acquire the same rigor of method, the same precision of language and the same exactitude of results as characterize the physical sciences. Medicine, which is nothing more than the physiology of the sick man, will not delay to follow in the same direction and reach the same dignity. Then all those false interpretations which, as food for the weakest minds, have so long disfigured medicine, will disappear.

And this same idea was preached by Magendie's most distinguished pupil, Claude Bernard, when he said:

> The prudent and reasonable course is to explain all that part of disease which can be explained by physiology, and to leave that which we can not so explain to be explained by the future progress of biological science.

In considering science as a factor of human knowledge it is necessary to dissociate the mind from that provincialism which would hold that each country has its own special kind of science, a form of pleading which Rubner once endeavored to expound. American students, with their extreme loyalty to everything which may be good or bad about the educational institution to which accident may have attached them, are inclined to be narrow enough without accepting such a doctrine as this. The truth is the same whether it be in Boston or New York; in London, Paris or Berlin. Only the interpretation of the truth varies with the education of the mind of the individual. The inspiration and opportunity for seeking for the truth depends also on the human factors involved.

Before the war medical education in this country was rapidly advancing. In all the great centers men lived whose primary pleasure was the search for understanding regarding the complex processes of life in health and in disease. Such work brings joy to the worker or he would not do it. I recall a talk with my friend, Phoebus Levene. He had given a student the problem of finding the formula for chondroitin sulphuric acid and a year had passed without result. Levene said to his pupil:

> Work another year and then you will have it, and when all these men whose names are in the papers every day are dead, buried and forgotten, some one, long hence, when passing by will see this formula and will say of you "he painted that little picture."

To what extent this doctrine of future reward may affect the scientific seeker after knowledge can not be told, but there is no doubt that the chief origin of successful research lies in the love of it, and the joy of

discovery of new things and their understanding. Of course, there are many factors which enter into the life of the adventurer into the unknown. One of the most powerful controls in scientific life is criticism. Pflüger has stated that criticism is the mainspring of every advance. Scientific criticism begins with the scientist himself, and then he extends it to others and in turn receives external aid in the revision of his own opinions. Sometimes this criticism is friendly; sometimes bitter. Questions of priority also arise. It seems that in the future the most courteous treatment would be to commence all polemical discussions under the caption "The errors of the author and his critics" and to remember that as far as priority is concerned a man's influence is equal to the sum of all the influences of his life and that questions of priority as between men are usually insignificant and unimportant. I overheard one of Voit's assistants say to him, "Your views, Professor, are bound to win" and Voit turned upon him in anger, saying, "It makes no difference *who* is right, so long as the truth is found."

The quality of mind is of interest in considering scientific types. Liebig was a dunce at school and his teacher ridiculed his ambition to become a chemist. Helmholtz studied the refraction of light with a prism under his desk during Latin recitations when he was a boy. Helmholtz, on the occasion of his seventieth birthday, stated that he had never had a great idea come to him when he was at his desk, nor when he was tired, nor after taking a glass of wine, but usually such had come to him when he was walking in the garden musing of other things. The scientist must have leisure to think over the problems which offer and he must have a certain discrimination in order to distinguish between the things which are worth doing and those which are not. To do this requires a certain delay in action in order that plans may be matured. The individual who can not be happy unless he is at work at full power all the time is much less likely to accomplish successful scientific work than he who will not commence a research until he has satisfied himself that it is worth doing. It is not to be denied that this essential qualification of scientific life is frequently regarded with scorn by the busy practitioner of medicine, who gives himself no time either for thought or study.

Though the capacity for discovering new things may not be given to all, yet all should have the training which comes from an environment, such as that existing in the Harvard Medical School, where the students are educated by men whose lives have been illumined by creative thought. Such men are patrons of the future, benefactors of mankind.

The war brought a temporary halt to promising activities. Many instances can be cited. In Bellevue Hospital Du Bois had just completed his calorimetric studies upon malarial fever. He was investigating the water output of the body during the night sweats in tuberculosis and, for the first time, the technic had been perfected so that this factor in the regulatory mechanism of the heat control could be studied. The declaration of war against Germany meant "down tools" for him, and he gave his services to his country. The important point now is to have the work completed with as little delay as possible.

But the war has also developed much that is of great value to the nation and medical science has been notably advanced in many lines. The work on "Trench Fever," edited by Major Richard P. Strong, of the Harvard Medical School, is one of the great medical triumphs of the war. It seems as though the value of science for the welfare of the nations of the world must have become more firmly defined in the minds of men than ever before. Let us hope that this is true.

Now is the time to take up the work where it was left at the outbreak of the war. It is our duty not only to continue but also to expand the work—to multiply facilities and to furnish a living wage. Scientific laboratories everywhere should be free from all commercial taint, which distracts and finally destroys. A laboratory should be a little community, happy in its daily life, and doing work worth

while for the advancement of knowledge. The actual workers therein should be full-time men. Whether the titular chief should always be such is an undecided question and is largely dependent upon the personal equation.

Such laboratories as these are the glory of the Harvard Medical School. To the young men who are to be the leaders of the future belongs the present opportunity. The lands of Europe are wasted and impoverished by war. Only the wounded and the physically unfit were allowed to study medicine in England last winter. The men of England and the men of France have fought for four long years; ours for four months. The young physicians of America of the present generation have the obligation and may, perhaps, deserve the credit of establishing in the days to come, the dreams for medicine of Magendie and of Claude Bernard, thus insuring a notable scientific era in this great land of ours. Only thus can medicine progress; only through observation and experiment can the world grow in wealth of knowledge. We may thus endeavor, "as Lord Bacon says, to frame the human understanding anew."

GRAHAM LUSK

THE SMITHSONIAN "SOLAR CONSTANT" EXPEDITION TO CALAMA, CHILE

IN 1916 Secretary Walcott appropriated from the income of the Hodgkins Fund to equip and maintain for several years such a station in South America, but owing to the war it was temporarily located in the North Carolina mountains in 1917. The station proved very cloudy, and now it has proved possible though very expensive to go to Chile.

Dr. C. G. Abbott has reported to the National Academy of Sciences that after correspondence with the South African, Indian, Argentine and Chilean meteorological services he became convinced that near the nitrate desert of Chile is to be found the most cloudless region of the earth easily available. Dr. Walter Knoche, of Santiago, has most kindly furnished two years (1913 and 1914) of unpublished daily meteorological records for a number of Chilean stations. In his judgment the best station is Calama on the Loa River, Lat. S. 22° 28′, Long W. 68° 56′, altitude 2250 meters. For the two years the average number of wholly cloudless days is at 7 A.M., 228; 2 P.M., 206; 9 P.M., 299; and of wholly cloudy days, none. The precipitation is zero; wind seldom exceeds 3 on a scale of 12; temperature seldom falls below 0° or above 25° C.

The expedition, Director Alfred F. Moore, Assistant Leonard H. Abbot, reached Calama June 25, 1918, equipped with a full spectrobolometric, pyrheliometric and meteorological outfit of apparatus, as well as with books, tools, household supplies and everything foresight could furnish to make the work successful and life bearable. The Chilean government has facilitated the expedition in many ways, and the Chile Exploration Company has given the expedition quarters and observing station at an abandoned mine near Calama. Many others in Antofagasta, Chuquicamata and Calama have been of great assistance.

The apparatus is set up in an adobe building about 30 feet square, in which the observers have sleeping apartments. A 15-inch two-mirror coelostat reflects the solar beam to the slit of the spectro-bolometer. A Jena ultra-violet crown glass prism and speculum metal mirrors are used in the spectroscope The linear bolometer is in vacuum, and constructed in accord with complete theory for greatest efficiency. Its indications as measured by a highly sensitive galvanometer are recorded photographically on a moving plate which travels proportionally to the movement of the spectrum over the bolometer. Successive bolometric energy spectrum curves each occupying 8 minutes of time are taken from early morning till the sun is high and are thus recorded on the plate. Their intensity indications at 40 spectrum positions are reduced by aid of a special slide rule plotting machine.

A pair of silver disk pyrheliometers is read simultaneously with each spectro-bolographic determination. Measurements of humidity, temperature, and barometric pressure accom-

pany the bolometric observations. Also a pyranometer is employed to determine the sky radiation.

The young men find pleasant companions at the great copper mine at Chuquicamata. At present they are boarding with a Chilean family at Calama, but as both are good cooks they may wish to board themselves. The railway and the river both pass the town of Calama, so that there is no such desert isolation as might be feared. To the east are the Andes Mountains. The peaks in that neighborhood rise to 16,000 or 17,000 feet. Some are volcanic but none of these are very near.

It is hoped that the work will be continued for several years at least, and that nearly daily observations may be obtained. The application of the results to meteorology is something which may prove to have great possibilities. To exploit them a long and nearly unbroken series of solar radiation observations must be obtained.

Observations were begun on July 27, under exceptionally favorable conditions of the experimental equipment. At latest report, on October 22, complete solar constant determinations had been made on five days in July, twenty-seven days in August, eighteen days in September and nineteen days in October, a total of sixty-nine days out of eighty-eight days elapsed.

Owing to the great zeal and industry of the observers and the excellent special computing facilities at their disposal, all of the observations had been completely worked up to date. If necessary for meteorological purposes it would be possible for them to telegraph the solar constant value on the same day observed.

Notwithstanding the high percentage of cloudless days, the sky conditions have not proved quite as satisfactory as had been hoped, owing to the presence of considerable haze and the occasional formation of cirrus clouds. While these modifications of transparency are not serious enough to introduce large errors in the results (all values have fallen between 1.88 and 2.02 calories) they are serious obstacles to the investigation of variations of the sun which should be measured to one per cent. of the solar constant or better. Efforts are now being made with good prospect of success to devise an instantaneous method of determining the sky transparency so as to avoid error from changes of transparency occurring progressively during several hours.

The average value of the solar constant as thus far obtained at Calama is 1.951 calories per square centimeter per minute. The mean of all values obtained prior to 1914 was 1.932. At present the solar activity as measured by sun-spots is still large, though declining. In view of the past measurements of the solar constant and past investigations of the meteorological phenomena of the world it is to be expected that somewhat lower values of the solar constant and somewhat more cloudless observing conditions will be found at Calama after a year or two.

THE HARVARD ENGINEERING SCHOOL

Following the decision of the Supreme Court of Massachusetts that the agreement with the Institute of Technology is not in accord with the will of the late Gordon McKay, Harvard has reorganized its engineering school on a basis satisfactory both to the trustees of the McKay estate and to the governing boards of the university. The new plan, however, will be subject to the approval of the Court. The full text of the vote passed by the Harvard Corporation and consented to by the Board of Overseers establishing the school follows:

Voted to establish a School of Engineering upon the following basis:

Whereas, in reconstructing an engineering school in Harvard University it is important to lay stress upon fundamental principles; to make use of the courses in Harvard College so far as is consistent with the curriculum of the school; and to conduct the school under a faculty of its own the corporation hereby adopts the following plan of organization:

1. Name. The name of the school shall be the Harvard Engineering School.

2. Departments. The school shall provide "all grades of instruction from the lowest to the highest" and the instruction provided shall "be kept

accessible to pupils who have had no other opportunities of previous education than those which the free public schools afford.''

3. Admission. Inasmuch as the entrance examinations to Harvard College now admit freely boys from good high schools, the requirements for admission to the engineering school shall be the same as for admission to Harvard College. Admission to advanced standing and special study shall be administered by the engineering faculty.

4. Fees. The fees of students in the school shall be the same as for students in Harvard College, except that supplementary fees for additional or for laboratory courses may be charged.

5. Class rooms and laboratories. The work of the school shall be carried on in the class rooms and laboratories of the university, but arrangements may be made from time to time for the use of the facilities of other institutions for any part of the work (in its advanced technical courses) when the needs, financial resources and best interests of the school so require.

Arrangements for the use of facilities of other institutions, or the interchange of instruction, shall be made for a period of only one year at a time.

When there shall be income from the funds of the McKay endowment available, in the judgment of the president and fellows, for the construction of new buildings for the engineering school, containing offices, laboratories, workrooms and classrooms, such buildings are to be constructed on Harvard University grounds and bear the name of Gordon McKay.

6. Faculty. The faculty of the school shall consist of the president of the university and of those professors, associate professors, assistant professors and instructors appointed for more than one year, the greater part of whose work of instruction is done in the school, and of a limited number of other teachers of subjects offered in the school to be appointed in the usual way. The term of appointment of a teacher from any other institution who gives instruction in the school shall be for one year only; his title shall be lecturer, instructor or assistant.

The faculty shall, under the direction of the corporation, have control of all instruction given in the school wherever the instruction may be given.

7. Degrees. A student satisfactorily fulfilling the requirements of a prescribed four-year program in any of the engineering fields shall be awarded the degree of bachelor of science in that field.

The degree of master of science, or an equivalent degree, shall be awarded upon the successful completion of at least one additional year of study. For the doctor's degree the requirements shall be similar to those in the graduate school of arts and sciences.

8. Credit for instruction elsewhere. As in the case of every faculty the faculty of the engineering school may, in its discretion from time to time, allow credit towards the degree under its control for instruction received at another institution or by other instructors.

9. Courses in the school, or the services of its staff, may be made available to qualified students of other institutions.

10. This plan shall be submitted to the Supreme Judicial Court of Massachusetts, or a justice thereof, for approval.

The faculty of the school of engineering is as follows:

A. Lawrence Lowell, president; George F. Swain, Gordon McKay professor of civil engineering; George S. Raymer, assistant professor of mining; Arthur E. Kennelly, professor of electrical engineering; Henry L. Smyth, professor of mining and metallurgy, and director of the mining and metallurgical laboratories; Harry E. Clifford, Gordon McKay professor of electrical engineering; Lewis J. Johnson, professor of civil engineering; Albert Sauver, professor of metallurgy and metallography; George C. Whipple, Gordon McKay professor of sanitary engineering; Comfort A. Adams, Abbott and James Lawrence professor of electrical engineering; Frank A. Kennedy, associate professor of engineering drawing; Lionel S. Marks, professor of mechanical engineering; George W. Pierce, professor of physics and director of the Cruft Memorial Laboratory; Hector J. Hughes, professor of civil engineering and director of the engineering camp; Edward V. Huntington, associate professor of mathematics; Gregory P. Baxter, professor of chemistry; Lawrence J. Henderson, assistant professor of biological chemistry; Louis C. Graton, professor of economic geology; Arthur E. Norton, assistant professor of mechanical engineering; Harvey N. Davis, assistant professor of physics; Grinnell Jones, assistant professor of chemistry; Emory L. Chaffee, assistant professor of physics.

THE MEDALLISTS OF THE ROYAL SOCIETY

AT the anniversary meeting of the Royal Society on November 30, medals were pre-

sented by the president, Sir J. J. Thomson, as announced in last week's issue of SCIENCE. The characterization of the work of the medallists, as printed in *Nature,* was as follows:

The Copley Medal is awarded to Hendrik Antoon Lorentz, For. Mem. R. S. Lorentz is generally recognized as one of the most distinguished mathematical physicists of the present time. His researches have covered many fields of investigation, but his principal work deals with the theory of electrons and the constitution of matter considered as an electro-dynamic problem. When Zeeman had discovered the effect of magnets on spectroscopic lines, he perceived at once the theoretical bearing of the effect, which led to the discovery of the circular polarization of the components of the lines split up by magnetic force. Lorentz's name is also associated with that of Fitzgerald in the independent explanation of the Michelson-Morley effect, from which far-reaching consequences have been derived. An important optical relationship between the density of a medium and its index of refraction (independently by L. Lorentz) was published in 1878, and he has been an active and fruitful investigator ever since.

A Royal Medal is awarded to Professor Alfred Fowler. Professor Fowler's investigations have been, in the main, on spectroscopy, and one of his specialties has been the identification and reproduction of celestial spectra in the laboratory. His extraordinary success in identification of this kind is attributable in part no doubt to a special intuition, but also to a great and laboriously acquired knowledge of detail. For instance the origin of the bands dominating the spectra of stars of Secchi's third class remained a mystery for many years. Fowler showed that they were due to titanium oxide. He accounted for many of the band-lines in the sun-spot spectrum by showing that they belonged to "magnesium hydride," and several other instances of scarcely less importance might readily be given. Another important branch of his work is connected with spectrum series. The lines of many elements which appear in the arc spectrum have long been classified into series, and empirical relations have been obtained between the position of a line in the series and its frequency of oscillation. Those lines which are characteristic of the spark, and require higher stimulation, were not included in the scheme. Fowler was the first to show that the spark-lines form series at all. For this purpose he had first to work out experimentally the conditions for obtaining an adequate number of lines belonging to these series. Helium and magnesium were the elements chiefly studied. It was found that the spark-line series could be represented by formulæ similar to those which hold good for the arc lines, but with a fourfold value of the universal constant holding for the arc-line series of all the elements.

Apart from these investigations, leading to results so simple and definite, there is much descriptive work on spectra standing to the credit of Professor Fowler and his pupils, which is highly appreciated by specialists for its accuracy and technical value.

A Royal Medal is awarded to Professor Frederick Gowland Hopkins. Professor Hopkins was among the very earliest, if not actually the earliest, to recognize and announce that minute quantities of certain bodies, the nutritive value of which had hitherto been unsuspected, exert an enormous influence upon growth and upon normal adult nutrition. He showed that without these accessory factors—vitamines—a diet otherwise full and seemingly complete is incapable of allowing growth, and even of maintaining body-weight or life. He has also made important researches into what may be styled the determination of the specific nutritive values of individual main components of the protein molecule; he has, for example, shown that when, from a certain diet which was proved to maintain nutrition satisfactorily, the two amino-acids, arginine and histidine, were together removed, the diet, though amply sufficient in energy and fully assimilable, failed to maintain life. More recently Hopkins has attacked the question whether an animal's life can be maintained under the condition that, in place of protein or of the entire set of amino-acids constituting protein, a limited few of the several representative types of these constituents are provided in the diet. He shows that when, instead of the eighteen different amino-acids composing the protein, five only are administered, death rapidly ensues if those five be selected from the simpler aliphatic components, *e. g.,* lucine, valine, alanine, glycine and glutamic acid, but that, on the other hand, nutrition and life are satisfactorily maintained, at least for a considerable period, if the five amino-acids given be chosen from the more complex types, such as tyrosine, tryptophane, histidine, lysine and cystine, which experiment has shown to lie outside the range of the synthetic power of the animal body.

The Rumford Medal is awarded to Dr. A. Perot and Professor Charles Fabry. MM. Perot and Fabry have introduced a new method of measuring

wave-lengths by an ingenious method of utilizing the luminous rings formed by interference between two reflecting plates. Their researches have proved of fundamental importance: (1) In comparing accurately the wave-lengths of different spectroscopic lines with that of some standard line. (2) In comparing directly the wave-length of the standard line with that of the standard unit of length. This comparison has confirmed in a remarkable way the previous measurements of Michelson, whose method is less direct and more liable to certain errors. The independent confirmation thus obtained has therefore placed the subject on a much firmer basis.

The Davy Medal is awarded to Professor F. Stanley Kipping. Professor Kipping has worked with distinction during the past thirty years on a great variety of problems connected with organic chemistry, involving fatty acids, derivatives of hydrindone, camphoric acid and its halogen compounds, the π-derivatives of camphor, racemism and pseudo-racemism, derivatives of quinquevalent nitrogen, organic compounds of silicon, including derivatives having optical activity due to the asymmetry of the silicon atom.

The Darwin Medal is awarded to Dr. Henry Fairfield Osborn. Dr. Osborn's chief work has been in paleontology, and, in connection with it, he has organized many collecting expeditions to the early Tertiary rocks of the west. One of the results of his work is the more precise determination of the relative ages of the extinct mammals in North America, and that has led to a correlation between the order of succession of the Mammalia in Europe and in America. A good deal of this work was summarized in his book, "The Age of Mammals in Europe, Asia and North America," published in 1910. In 1900 Osborn had come to the conclusion that the common ancestors of Proboscidia, Eirenia and Hyracoidea would be found in Africa; and the correctness of this view has since been confirmed by Dr. Andrew's discoveries in the Egyptian Fayum. Amongst the more important of Osborn's contributions to our knowledge of extinct vertebrata are his memoirs on the rhinoceroses, the horses, the titanotheres and the dinosaurs. In addition to all the work he has done personally, Dr. Osborn has had a wide and most beneficial influence upon biological research in North America, and he has produced a flourishing school of younger vertebrate paleontologists.

The Hughes Medal is awarded to Mr. Irving Langmuir. Mr. Irving Langmuir is a distinguished worker in the physics and methods of production of high vacua. He has studied the vapor pressure of platinum and molybdenum by heating fine wires *in vacuo* and noting the loss of weight. He has investigated the speeds of chemical reaction of different gases on various metals at very low pressures. He has investigated also the dissociation of hydrogen and its apparent abnormal heat conductivity, and the dissociation of chlorine and oxygen; also the chemical activity of dissociated hydrogen. His work on the emission of electrons from hot metals in high vacua led to the evolution of the "kenotron" and "pliotron," and of the "half-watt" lamp. His determination of the melting-point of tungsten is generally accepted. Much of his work, such as the investigation of the cause of blackening of tungsten lamps, is of commercial as well as of academic scientific value.

SCIENTIFIC EVENTS

THE BRITISH MEDICAL RESEARCH COMMITTEE[1]

UNDER the regulations for the Medical Research Fund Major Waldorf Astor, M.P., Dr. A. K. Chalmers (M.O.H. Glasgow), and Dr. George Murray, professor of medicine in the University of Manchester, retired last August. Major Astor was reappointed Chairman, and Dr. Henry Head, F.R.S., physician to the London Hospital and to the Royal Air Force Central Hospital, and Dr. Noël Paton, F.R.S., regius professor of physiology in the University of Glasgow, were appointed members of the Committee. It now consists, in addition to Major Astor (Chairman), Viscount Goschen (Treasurer), and Sir Walter Fletcher, M.D., F.R.S. (Secretary), of Dr. Addison M.P., Mr. C. J. Bond, of Leicester, Professor William Bulloch, F.R.S., Professor F. G. Hopkins, F.R.S., of Cambridge, Colonel Sir William Leishman, K.C.M.G., F.R.S., Dr. Henry Head, and Professor Noël Paton. Reference is made elsewhere (p. 579) to some of the chief points in the annual report. We may note in addition the statement that the committee has acted jointly with various government departments or other bodies, either in appointment or in nomination, with a view to meeting particular administrative needs demanding research work. The committee has in fact a

[1] From the *British Medical Journal.*

number of special committees, including those on the incidence of phthisis in relation to occupation; on surgical shock and allied conditions of which Professor Bayliss has become chairman; on the standardization of pathological methods, of which Professor Adami, F.R.S., is chairman; on salvarsan; on chemical warfare medical investigations; on anaërobic bacteria and infections, of which Professor Bulloch is chairman; on accessory food factors ("vitamines"), of which Professor Hopkins is chairman; on air medical investigations, of which Dr. Head is chairman; and on dysentery, of which Sir William Leishman is chairman. There is also an industrial fatigue research board, appointed last June by the Department of Scientific and Industrial Research jointly with the Medical Research Committee, to consider and investigate the relations of the hours of labor and of other conditions of employment, including methods of work, to the production of fatigue, having regard both to industrial efficiency and of the preservation of health, among the workers. Of this committee Professor Sherrington is chairman. In the introduction to the annual report reference is made to the cordial cooperation received from the Advisory Council of Scientific and Industrial Research, established in 1915. The field of research in every pure science, not less than that of inquiry in industrial science, lies so close at very many points to the fields of medical research, that no boundary line can be drawn. The committee looks forward to the progressive development in this cooperation with the department of scientific and industrial research, and finds new hope for the increasing effective organization of research work in all directions. "This," it is said, "should be an organization not imposed in any sense from above, but one derived from and inspired by the efforts of individual workers in the different fields of science, where the free university and other institutions of the country are pursuing together the common aims of the advancement of knowledge and the good of the state." In this connection it may be recalled that the Ministry of Health Bill provides that "the duties heretofore performed by the Medical Research Committee shall, after the commencement of this act, be carried on by or under the direction of a committee of the Privy Council appointed by His Majesty for that purpose." This would place the Medical Research Committee in a position analogous to that of the Advisory Council of Scientific and Industrial Research.

RESOLUTIONS IN HONOR OF DIRECTOR FREDERICK J. V. SKIFF

On the sixteenth of December Dr. Frederick J. V. Skiff, director of the Field Museum of Natural History, Chicago, was presented with engrossed resolutions by eighty-six of those affiliated with him in the museum, the occasion for this presentation being the twenty-fifth anniversary of the appointment of Dr. Skiff as director of the Field Museum. Dr. Skiff was the recipient of many congratulatory letters and telegrams. The resolutions are as follows:

On this, the occasion of the twenty-fifth anniversary of your appointment as director of this museum, we who are affiliated with you in the work of the museum unanimously extend to you our hearty congratulations upon your successful completion of so notable a term of service, and wish to express to you as well, our deep appreciation of the cordial relations which you have maintained with us during this period.

The task to which you were called twenty-five years ago presented, as we realize, peculiar difficulties. The plan and purpose of the museum were to some extent uncharted and the execution of even such plans as had been made called for the exercise of unusual administrative ability. The opportunity at hand at this time for creating a museum of world-wide scope and importance was known to be great, but the manner in which this opportunity should be improved, so far as administrative details were concerned, rested with you. With what high idealism, fixity of purpose and wisdom of direction you performed this task, the institution which exists to-day eloquently testifies. Whatever great accomplishments of service and progress await the museum in the future, we feel sure that it will always owe its success to the broad foundations which it has been your privilege and at the same time your high honor to have laid. Only one of broad, well-balanced and highly cul-

tured mind could have conceived and carried on as you have done the symmetrical and rapid progress which has characterized the institution. That in addition to this great work you have been able also to render highly distinguished services to various international enterprises in the form of world expositions, is another indication of the wide range of your powers.

Your broad qualities of mind have been accompanied by a warmth of heart which has bound us to you in especial affection. Our felicitations on this occasion spring therefore from sentiments of deep personal regard. You have been to each of us a wise counselor and faithful friend, no less than trusted leader and able administrator.

It is our hope that you may be spared to direct the activities of this institution for many years and to enrich with your friendship and counsel the lives of each of us and of all others who shall be privileged to come within the circle of your companionship.

THE WORK OF DR. C. G. ABBOT

DR. CHARLES GREELEY ABBOT has been appointed assistant secretary of the Smithsonian Institution. Dr. Abbot was born in Wilton, New Hampshire, May 31, 1872. He was graduated from the Massachusetts Institute of Technology, class of 1895, with the degree of Master of Science, and in 1914 he was awarded the Honorary Degree of Doctor of Science by the University of Melbourne.

Dr. Abbot was appointed assistant to Secretary Langley in the Smithsonian Astrophysical Observatory in 1895, and has been engaged continuously in original researches on solar radiation in cooperation with Dr. Langley up to 1906, when he assumed entire charge of that work as director. His studies covered the fundamental problems in connection with the amount and variability of solar radiation, its absorption in the solar and terrestrial gaseous envelopes, and the effects of its variability on climate.

In recognition of the character of his work, Dr. Abbot has received the Draper gold medal from the National Academy of Sciences, the Rumford gold medal from the American Academy of Arts and Sciences, and membership in the National Academy of Sciences, the American Academy of Arts and Sciences, the Astronomical and Astrophysical Society of America, the Royal Astronomical Society of Great Britain, the Société Astronomique de France, the Society of Astronomy in Mexico, the Academy of Modena in Italy, the Deutsche Meteorologische Gesellschaft in Germany, and other organizations. The results of his work have been published largely in the *Annals* of the Astrophysical Observatory. He is also the author of a work entitled "The Sun," published in 1911, and has contributed many scientific papers to special astronomical and astrophysical journals.

THE ANNUAL MEETING OF THE AMERICAN ORNITHOLOGISTS' UNION

THE thirty-sixth annual meeting of the American Ornithologists' Union was held in New York City, November 11, 1918. Owing to the epidemic of influenza the public meetings for the presentation of papers were omitted and the sessions were limited to business meetings of the council and fellows and members. The election of officers resulted in the choice of the following officers for the ensuing year: *President,* John H. Sage, Portland, Conn.; *Vice-presidents,* Dr. Witmer Stone, Philadelphia, and Dr. George Bird Grinnell, New York; *Secretary,* Dr. T. S. Palmer, 1939 Biltmore St., Washington, D. C.; and *Treasurer,* Dr. Jonathan Dwight, New York. Five additions were made to the list of honorary fellows and 14 foreign ornithologists were enrolled as corresponding fellows. The honorary fellows elected were: Dr. Roberto Dabbene, of Buenos Aires; Dr. Alwyn K. Haagner, of Pretoria, Transvaal; Dr. Einar Lönnberg, of Stockholm, Sweeden; Dr. Auguste Ménégaux, of Paris, and Dr. Peter Suschkin, of Kharkov, Russia. Five new members, Dr. Harold C. Bryant, George K. Cherrie, Lieutenant Ludlow Griscom, Lieutenant J. L. Peters and R. W. Williams, and 147 associates were added to the rolls.

Although the union has had seventy-five of its younger and more active members in military and naval service, it has survived the war without suffering any decrease in its membership, its income, or in the size of its journal.

It has not found it necessary to increase its dues and the past year has proved one of the most prosperous in its history.

The next meeting in 1919 will be held in New York City.

SCIENTIFIC NOTES AND NEWS

THIS number of SCIENCE completes twenty-four years of weekly publication under the present editorial management. The New Era Printing Company have been the printers of the journal during this period, and it is becoming to put on record its obligation to them for efficient and distinguished work.

The American Association for the Advancement of Science and the national scientific societies affiliated with it are meeting this week at Baltimore, the opening session being held on the day the present issue of SCIENCE is mailed. We hope to print next week the address of the retiring president, Professor Theodore W. Richards, to be followed by the addresses of the vice-presidents and other addresses and papers presented at the meeting.

DR. A. SMITH WOODWARD, keeper of the Geological Department of the British Museum (Natural History), has been awarded the Cuvier prize by the French Academy of Sciences.

SIR HERBERT JACKSON has been appointed director of the British Scientific Instrument Research Association. He has resigned from the Daniell professorship of chemistry, King's College, London.

LIEUTENANT COLONEL RAFFAELE BASTIANELLI, professor of surgery in the University of Rome, has been elected an Honorary Fellow of the New York Academy of Medicine.

PROFESSOR G. F. NOVARO retires this year from the chair of clinical surgery at the University of Genoa, having reached the age of seventy-five. He is a senator of the realm.

LIEUTENANT COLONEL FRANK P. UNDERHILL, commanding officer of the Yale Chemical Warfare Unit, has recently returned from France, where he went to introduce a cure for men gassed at the front. This new method was adopted.

DR. A. O. LEUSCHNER, of the University of California, will relinquish the duties of dean of the graduate division at the university at the end of the academic year, and has received a commission as major, Chemical Warfare Service, with headquarters at Washington, and has been detailed to the National Research Council since the armistice. Captain W. H. Wright, astronomer in the Lick Observatory, is connected with the Range Firing Section, Ordnance Corps, Aberdeen Proving Ground. Dr. H. D. Curtis, astronomer in the Lick Observatory, is engaged in war work at the Bureau of Standards. Dr. Russell Tracy Crawford, assistant professor of astronomy in the University of California, is major in the Signal Corps, U. S. Army, at the Air Balloon School, Ft. Omaha. Dr. Dinsmore E. Alter, instructor in astronomy, University of California, recently appointed assistant professor of astronomy and physics, University of Kansas, is major in the Coast Artillery Corps, U. S. Army, in charge of the Enlisted Specialists School, Ft. Scott, California. Wallace Campbell, fellow in astronomy at the University of California, lieutenant in the engineer Corps, U. S. Army, is in France with the Expeditionary Forces.

DR. HUGH P. BAKER, who for nearly two years has been serving as a captain in the U. S. Army, has been released from service and has returned to resume his duties as dean of the New York State College of Forestry at Syracuse University. On account of an injury and because of his special training, Captain Baker had far the last few months been assigned to special investigative work for the Intelligence Bureau of the General Staff at Washington, D. C. Professor F. F. Moon, of the New York State College of Forestry at Syracuse University, who has been dean of the college during the absence of Dean Hugh P. Baker, has on the return of the latter to his work, been granted a year's leave of absence to begin immediately.

AT the school of mines of the University of Missouri Carroll R. Forbes, major of engi-

neers, will return to his work as professor of mining on January 3; Charles Yancy Clayton, who has been working in the Bureau of Mines at Pittsburgh, Pa., on metallographic work for the Ordnance Department, will resume his duties as assistant professor of metallurgy; Captains E. S. McCandliss, F. E. Dennie and Lieutenant R. S. Lillard, of the mines faculty, are with the U. S. Engineers Army of Occupation in Germany, and Captain F. H. Frame, assistant professor of physics, is with the Ordnance Department in France.

DR. LAFAYETTE B. MENDEL, professor of physiological chemistry at Yale, is attending the meetings of the Inter-Allied Food Commission in Europe.

DR. H. N. HOLMES, of the chemistry department at Oberlin College, has been released from part work in order to carry out research for the National Research Council, having been appointed a member of a National Committee of four on colloids.

CAPTAIN W. A. FELSING, Ph.D., has been appointed adjunct professor of chemistry at the University of Texas. He has been stationed for some time past at the government arsenal at Edgewood, Md.

CAPTAIN PAUL J. HANZLIK, Medical Corps, U. S. A., chief of the Dermatological Unit, Chemical Warfare Service, Camp Leach, American University, has returned to his position of assistant professor of pharmacology, School of Medicine, Western Reserve University.

RAYMOND L. BARNEY, scientific assistant at the Homer station of the U. S. Bureau of Fisheries, has been promoted to be superintendent and director of the Beaufort, N. C., biological station, to succeed S. F. Hildebrand, who was promoted last July to be superintendent of the Key West (Fla.) biological station.

AT its last meeting the Rumford Committee of the American Academy of Arts and Sciences voted an appropriation of $250 to Dr. Louis T. E. Thompson, of Clark University, for the development of a gun-sight with two magnifications, for application to anti-aircraft guns.

MISS ELIZABETH S. WEIRICK, for the past eight years instructor in chemistry at Pratt Institute, Brooklyn, N. Y., has resigned her position there to take up the work of textile chemist in the chemical laboratories of Sears Roebuck and Company, Chicago.

MR. JOHN E. SCHOTT, formerly an industrial fellow at Mellon Institute, has accepted a position with the Experimental Division of the Hercules Powder Co., Kenvil, N. J.

DR. H. N. WHITFORD has recently returned from a six month's trip in the southern part of Brazil, made in behalf of the Yale Forestry School. While there he was engaged in propaganda work in forest conservation and investigative studies. He had occasion to visit one of the largest hard wood sections in the states of Espirito Santo and Minas Geraes. He also spent some time in the Araucaria forests of southern Brazil. This latter is the largest coniferous forest in the southern hemisphere.

DR. J. J. GALLOWAY, of the department of geology of Columbia University, spent the past summer in the Mexican states of Yucatan, Campeche and Quintana Roo, studying the geology and petroleum resources of the peninsula.

DR. L. H. BAILEY is working at the Gray Herbarium of Harvard University completing the determinations of the collection of plants he made in China in the spring of 1917.

MR. C. T. R. WILSON has been elected president of the Cambridge Philosophical Society. The vice-presidents are Dr. Doncaster, Mr. W. H. Mills and Professor Marr.

AT the annual meeting of the Royal Society of Edinburgh Dr. J. Horne was elected president. Vice-presidents were elected as follows: Professor D'Arcy Thompson, Professor J. Walker, Professor G. A. Gibson, Dr. R. Kidston, Professor D. Noël Paton and Professor A. Robinson.

THE Swiney lectures on geology of the Royal Society of Arts in connection with the British Museum (Natural History), are given

during December and January by Dr. Thomas J. Jehu. The subject of the course, which consists of twelve lectures, is "Man and his ancestry."

PROFESSOR J. PAUL GOODE, of the University of Chicago, gave an address entitled "The Prussian dream of world conquest" at the annual convention of the National Association of Investment Bankers, at Hotel Traymore, Atlantic City, December 9.

A MEMORIAL service for Samuel Wendell Williston, formerly professor of paleontology in the University of Chicago, was held at the university on December 8. The speakers were Professor E. C. Case, of the University of Michigan, and Professor Stuart Weller, of the department of geology and paleontology, and Professor Frank R. Lillie, chairman of the department of zoology.

B. O. SEVERSON, associate professor of animal breeding in the Kansas State Agricultural College, died of influenza on December 4.

CAPTAIN ADELBERT P. MILLS, assistant professor of materials in the college of civil engineering, Cornell University, died at a hospital in France, on October 20, of cerebro-spinal meningitis, aged thirty-five years.

LOUIS C. STERN, a civil engineer, died on November 30, of pneumonia, following epidemic influenza, in Boulder, Col. Mr. Stern was connected for some years with the Bureau of Surveys of Philadelphia and with the Pennsylvania State Department of Health, in the supervision of water supplies and sewage disposal throughout the state. At the time of his death he was instructor in sanitary engineering at the University of Colorado.

MR. ROBERT JOHN POCOCK, director of the Nizamiah Observatory, Hyderabad, died on October 9, aged twenty-nine years.

Nature states that the success of the British Scientific Products Exhibition, held at King's College, London, during the past summer, has led the British Science Guild to decide to organize another exhibition next year. The main object of the new exhibition will be to stimulate national enterprise by a display of the year's progress in British science, invention and industry.

CONTESTS for the production of wheat of pure quality have been announced by the Italian Minister of Agriculture. All entrants must cultivate land in the Roman Campagna, and the kind of wheat to be grown must be selected from those announced by the Ministry which grew most favorably in that district. Contestants, to be eligible to the prizes must raise at least 20,000 pounds of wheat, of which at least half must be good for seed. The prizes offered are $400, $300, $240, $200, $160 and $100.

ACCORDING to a press report an institute for scientific-technical research for problems connected with iron and steel manufacture is being established by the Ernesto Breda Company, of Milan. This is one of the first instances in Italy of the linking together of a scientific institute with an industrial concern. At the Breda plant in Milan new scientific theories and methods formulated in the institute for research will be tried out in the plants. The institute will offer to young men desirous of learning the iron and steel industry an opportunity of learning not only the science of metallurgy, but also its practical application. The establishment of the institute at the Ernesto Breda plant in Milan came in response to an appeal for the establishment of such institutes issued by the Scientific-Technical National Committee for Italy.

AT the annual meeting of the Rhode Island Medical Society, the trustees of the Fiske Fund proposed the following subject for the prize essay for 1919: "Recent Classification and Treatment of Pneumonia." The prize for the best essay is $200. Each competitor must forward to the secretary of the trustees, on or before May 1 of the year of the competition, a copy of his dissertation. The trustees are Drs. Gardner T. Swarts, John M. Peters and Jesse E. Mowry, all of Providence. Dr. Peters is secretary.

A DINNER to celebrate the quartercentenary of the granting of its charter to the Royal College of Physicians of London by King Henry VIII was, as we learn from the *British Medical Journal,* held in France on September 23, and was attended by almost all of the Fellows of the College now serving in that country, to the number of something less than a score. The toast to the College was proposed by the chairman, Major-General Sir Wilmot Herringham, C.B., A.M.S., and a congratulatory address to the College was signed by those present.

THE American Public Health Association held its postponed annual meeting in Chicago, December 9 to 12. The program was designed to bring out all available information concerning the management of epidemic influenza, though other aspects of public health were not neglected. Among the papers on the program were: "Etiology of Influenza," by Major William H. Welch; "Mobilization of Medical and Nursing Forces," by Assistant Surgeon-General J. W. Schereschewsky; "Influenza and Pneumonia Vaccines," by Dr. E. C. Rosenow; "The Use of Sera in Influenza," by Drs. McGuire and Redden; "The Face Mask," by Colonel Charles Lynch and Dr. George Weaver; "Organization of State and Federal Forces in Epidemics," by Assistant Surgeon-General A. W. McLaughlin and Dr. E. R. Kelley; "History and Statistics of the Epidemic," by Assistant Surgeon-General B. S. Warren.

THE U. S. Civil Service Commission announces an open competitive examination for specialist in animal husbandry and dairying at an entrance salary ranging from $1,800 to $2,500 per year. This examination is scheduled to fill a vacancy on the editorial staff of *The Experiment Station Record,* States Relations Service, U. S. Department of Agriculture, and the duties of the appointee will consist mainly of the preparation of technical abstracts of the current scientific literature in animal husbandry (including animal breeding and feeding) and dairying (including dairy farming). Competitors will not be required to report for examination, but must submit applications and other material on or before January 7, 1919.

THE Bureau of Standards has published a "Metric Manual for Soldiers," the aim of which is to give to the American soldiers the grasp of the metric system which will enable them to think and work in metric units. As recommended no tables of equivalents need be memorized. Brief tables and a vocabulary are given for reference. The units are described by actual examples likely to be encountered in military work.

THE comet discovered by Professor Schorr, of Hamburg Observatory, on November 23, was observed on November 30 from the Naval Observatory at Washington, and the Yerkes Observatory in Wisconsin, according to telegrams received at the Harvard Observatory. The comet is very faint, being of the fourteenth magnitude, and is visible only in large telescopes. It is in the constellation Taurus, not far from the bright star Aldebaran.

ANNOUNCEMENTS have been made in the *Journal* of the American Medical Association of a Spanish edition, the initial number of which will appear early in January. For the time being it will be issued semi-monthly. It is proposed to include in it practically all the scientific matter that appears in the *Journal.* Original articles and editorials that are of local or ephemeral interest will not be included.

UNIVERSITY AND EDUCATIONAL NEWS

THE sum of £20,000 has been given to the George Watson's College, Edinburgh, by Mr. James Glass, of London, in aid of the establishment of a school of chemistry at that institution.

THE faculty of medicine of Western University, London, Ont., is planning the erection of a new medical college building at an estimated cost of $100,000.

A RESEARCH fellowship of the annual value of £150 has been founded at Guy's Hospital in

memory of the late Lieutenant R. W. Poulton Palmer and his sister, the late Mrs. E. H. A. Walker, the object of which will be the investigation of obscure diseases in man.

A fire on the night of December 17 in the basement of Havermeyer Hall, the chemical laboratory of Columbia University, caused damage estimated at $10,000.

Dean Edward A. Birge has been elected president of the University of Wisconsin to succeed the late Charles R. Van Hise. Dean Birge will serve for two years, when he expects to retire at the age of seventy. He has been a member of the Wisconsin faculty in the department of zoology since 1875, and served as acting president of the university from 1900 to 1903.

Dr. Harold C. Chapin, of the National Carbon Company in Cleveland, has accepted an associate professorship of chemistry at Lafayette College.

The title of emeritus professor of experimental philosophy has been conferred upon Dr. E. H. Griffiths, F.R.S., on his retirement from the principalship of the University College of South Wales and Monmouthshire.

DISCUSSION AND CORRESPONDENCE

AGE FLOW AND EBB OF THE EOCENE SEAS

We will agree with geologic writers from Wm. Smith's day to this that a typical geological cycle consists of a sequence of arenaceous, argillaceous and calcareous deposits, the strandline moving in as deposite-load increases; in place of littoral sands, clear-sea, calcareous matter eventually becomes dominant.

During the minor subdivisions of geologic time, the ages, for example, wherever continental shelves are very broad and near sea-level, slight changes of this datum plane may produce enormous strand-line shifting without bringing about extensive lime-forming conditions; clays will alternate with sand *ad infinitem,* characterized now by the life of the ocean's flood, now by swamp life during its ebb.

Our southern Eocene deposits seem to record three such flood stages, separated by two ebb stages.

1. *The Midway Stage* is the oldest, the most generally *marine* with an expanse of gulf waters stretching from South Carolina through west Tennessee and perhaps southern Illinois, thence through Arkansas, southwest to and beyond the Rio Grande.

2. *The Sabine* records the first ebb tide condition over this same great area, a condition conducive to the growth of swamp vegetation, hence the *lignitic* condition of the strata as we see them to-day.

3. *The St. Maurice Stage* records the second notable and generally *marine* condition over much of this area, though extending less deeply into the Mississippi Embayment.

4. *The Claiborne Stage* appears to be, save in Alabama itself, a second great *lignitic* formation. Even at Claiborne, just above the Upper Landing, a road-cut shows the famous marine "sand bed" invaded by lignitic materials.

5. *The Jackson Stage* may well be looked upon as the last and in some ways the most remarkable of the *marine* accumulations. A quarter of a century ago we marked out a great transgressional loop of this stage up into eastern Arkansas but there were then no known evidences of its occurrence in Texas. But the keen eyes of A. C. Veatch soon discovered such evidences in east Texas; others have made valuable contributions in the same direction, and it is quite likely that the *Ostrea contracta* (*georgiana*) beds on the Rio Grande are of this age. To the east, in Florida, Georgia and the Carolinas, Cook is doing yeoman's service in expanding our knowledge of this great terrane.

Our conclusions in tabular, condensed form appear thus:

Stage	Water Condition	Sediment
Jackson	*Flood*	*Marine*
Claiborne	*Ebb*	*Lignitic*
St. Maurice	*Flood*	*Marine*
Sabine	*Ebb*	*Lignitic*
Midway	*Flood*	*Marine*

The Potomac Basin seems to have been generally too deep to show similar responses in

character of deposition to slight changes of sea-level. Downwarped in Sabine times (in areas where now accessible) it remained flooded till into St. Maurice times without showing very rapid, or well-defined, sharp changes, faunal or lithological.

Vertebrate paleontology assures us that the holarctic waters have been somewhat drained off now and then during Tertiary times, else land areas have risen out of the seas, furnishing bridges for mammalian migration between the New and Old worlds. The correlation of holarctic with Gulf age tides is a fascinating problem for contemplation, if not for solution by present-day earth-science workers. Perhaps our co-workers on the West Coast may have arrived at some general conclusions regarding tide-level conditions there during the Eocene ages. These, it seems to the undersigned, might be of vast importance for working out the physical history of our Eocene series.

G. D. HARRIS

PALEONTOLOGICAL LABORATORY,
CORNELL UNIVERSITY,
December 5, 1918

HEREDITARY DEFICIENCIES IN THE SENSE OF SMELL

BLAKESLEE[1] has recently drawn attention to the fact that two individuals may exhibit marked degrees of sensitivity to the fragrance of verbena flowers. A given person, asked to judge between the blossoms of two plants, A and B, may declare the former fragrant but not the latter. From a second person we may get exactly the opposite response. To him B is fragrant but not A.

These differences which were found repeatedly and which seem to have been constant, suggest numerous interesting problems. They also serve to recall that practically nothing is known, or if known, at least not readily accessible to the general reader, on the heritability of differences in the sense of smell.

I have been asked on several occasions what might be expected from a mating involving a normal person and one devoid of a sense of smell and, until asked the first time, I did not know that there are people who not only can not recognize the difference between odors, but can not recognize odors at all.

Not long ago, an instance of this sort fell into my hands and though the family history is fragmentary, it may possibly, when pieced in with other fragments, acquire some little value.

The case in point is that of a young Russian Jew, a fugitive from Kiev. This man, M. is quite unable to distinguish odors in the usual way. Alcohol, or anything with a sufficiently high percentage of alcohol, is simply "felt." The same thing is true of illuminating gas. Ether and chloroform, when very concentrated, "choke"; when dilute, they produce a "feeling" similar to that caused by flowers. The latter, also, he is aware of, but not in the ordinary way. They emit, very decidedly, "something delicate"; but this something is registered as "a gentle sensation like breathing balmy air." Pepper, again, has "no odor," but it is irritating and its application is followed by the usual effects.

The M. family, one characterized incidentally by much stammering; by an early and complete loss of the incisors; by frequent hernia; a thumb nearly twice the normal width; excessive sex interest; and, very considerable mental powers, contains several individuals abnormal in their sensitivity to odors.

Among the immediate sibs of M. himself, two sisters are normal in this respect. One brother exactly duplicates M. and another has some slight capacity in detecting odors. The mother of these sibs was unable to detect odors and her father, in turn, is reported to have been similarly deficient.

Off-hand there are certain resemblances here to sex-linked inheritance. It is necessary only to assume that the mother had the necessary double dosage in order to have a fairly typical case. Moreover the likelihood of this interpretation being correct is enhanced by a circumstance which to some may appear to cloud

[1] "Unlike Reactions of Different Individuals to Fragrance in Verbena Flowers," A. F. Blakeslee, SCIENCE, N. S., Vol. XLVIII., p. 298.

the issue, namely, M. has a cousin defective in the same sense. This cousin is the daughter of a paternal aunt whose husband, from quite another family, is "smell-blind."

"After making inquiries," M. writes," among people I know to be from my former place of residence, I came to the conclusion that that locality inbreeds this defect so that quite a number are afflicted with it."

This, in case the trait is sex-linked, is exactly the condition necessary to explain the relatively large number of duplex females herein recorded.

Whatever may or may not be true, the trait has reappeared in one collateral and two direct generations. This is sufficiently frequent to warrant the assumption that "smell-blindness" is heritable, and, from its behavior in this pedigree, it should not be very surprising if further evidence were to place it in the list of sex-linked characters.

OTTO GLASER

DEPARTMENT OF BIOLOGY,
AMHERST COLLEGE

BIOLOGICAL PRINCIPLES IN THE ZOOLOGY COURSE

IN an article entitled "Botany after the War," Professor Bradley M. Davis[1] discusses the changes which a period of war adjustment is likely to bring to the teaching of botany in introductory courses. It is not necessary to read between the lines to detect that Professor Davis will welcome the changes that he anticipates. His interest is chiefly directed to the relegation of morphology—especially the morphology of types—to a less commanding position then it now enjoys. His general thesis is well embodied in his closing interrogation whether the first course will not "come more and more strongly to stand out as one that attempts nothing more than the grounding of fundamental principles and a selection of information with rather definite reference to its general and practical interests, or its broad philosophical bearing."

The writer has not followed the discussion in the *New Phytologist*, but the reference to it made in the cited article leads him to infer that the ideal course in botany has been realized in few, perhaps none, of our institutions. Such an inference with regard to botany seems not at all unnatural to one who is acquainted with the situation in the teaching of its sister science zoology. In the latter subject the type course has long been the dominant one, almost the exclusive one, an inheritance from the time when zoology was a purely morphological science. Several books, it is true, have been in recent years described by their authors as the product of a revolt against the type course; but they mostly contain internal evidence that the laboratory courses which they accompany in the authors' own laboratories still consist largely of the dissection of types. While these teachers recognize that fundamental principles, rather than a knowledge of animal types, is the desirable acquisition of the beginning student, they have not had the courage to make that acquisition possible in the laboratory as well as in the recitation and lecture.

There is no fundamental reason why the work of the laboratory may not be grouped exclusively around general principles instead of around phyla and classes. Why allow demonstration of the tenets of the cell doctrine to be picked up piece-meal in several courses when a brief exercise on a number of unrelated organisms accomplishes the same purpose more completely at the outset? The simpler activities of protoplasm may be studied even by beginners, by introducing at one time organisms from widely different groups. The first-hand study of the principles of ecology does not require a knowledge of large animal associations, but can be satisfactorily based upon two or three forms taken from different phyla; and it is seldom necessary to know regarding any one of these animals more than a small fraction of the anatomical facts which a type course would include, to explain for the beginner the relation of that animal to its habitat. In the type course homology must be taught very incidentally in almost arbitrary connection with some one form, or must wait until

[1] SCIENCE, N. S., Vol. 48, November 22, 1918, pp. 514–515.

a number of closely related types have been dissected; and in the meantime the student is endeavoring to assimilate a classification without a knowledge of the chief practical means of establishing a system of taxonomy. Nor is taxonomy itself necessarily excluded when types are abandoned. An exercise in which the principles of taxonomy are made clear by illustrative material from the whole animal kingdom gives the student a better conception both of classification and of the groups of animals than anything less than a very long type course could be expected to do. And finally, the argument that a type course exhibits a splendid evolutionary series loses its force when types may be supplanted by much better evidence from vertebrate and invertebrate fossils, from geographical distribution, and other sources. Moreover, certain phyla, as the echinoderms, never did have much evolutionary significance, when taken in connection with other phyla, yet the usual type course includes at least one echinoderm.

The objection is sometimes raised that a course based on principles instead of types gives a full knowledge of not a single animal. This objection, however, comes only from those to whom zoology has a special interest, and who will go on for advanced work in the same field; and in their second course they will get that complete information about some one animal which they desire. An elementary course based on principles should therefore be the best foundation for students of all grades of interest. To him who will never pursue another course in biology it gives the very things that will be of interest or value. To him who will specialize in the subject, it affords the best possible framework into which the details subsequently acquired can be fitted.

Unlike courses in elementary botany, if Professor Davis's paper is correctly interpreted, the course in zoology based on principles does not await the future for its realization. In at least one institution such a course is now in operation. In the University of Michigan the first course in zoology is of the kind described. Dissection of types is no longer practised, the entire laboratory work being collected around principles. It is a truly general course; first hand knowledge of the elementary facts from each of the main divisions of zoology is gained in the laboratory and from these facts fundamental principles are derived. It has been in operation for several years, and has more than justified its introduction. Such a course makes new demands on the text-book and on the mode of teaching, but these difficulties can be removed. It is likely to be a little more expensive to install than the type course, but its current expenses may well be less.

The sponsors of this course regard it as the best kind of course, whether after the war, during the war, or any other time. Whatever of practical or applied biology it contains is there, not for any benefit that may accrue to the nation in times of stress, but because of its general interest and importance. For it is clear that the amount of applied biology that could be included in a beginning course would not enable any one save his country, unless increased by practical courses to follow.

In pedagogical method the course on principles need not differ from the type course. The inductive method may be as consistently employed. Accuracy in observation is just as necessary. Correctness of interpretation is quite as essential. But this difference exists: the thing observed is itself of interest, or the interpretation is important. Features of an animal which are not of interest or are not important are omitted.

A. FRANKLIN SHULL
UNIVERSITY OF MICHIGAN,
ANN ARBOR, MICH.

INTERNATIONAL ORGANIZATION OF SCIENCE

TO THE EDITOR OF SCIENCE: The statement adopted by the Inter-Allied Conference held in London under the auspices of the Royal Society, SCIENCE, November 22, page 509, as a preamble to certain resolutions which are to be made public later, directs attention to the serious difficulties which the recent war has imposed on the international scientific projects already inaugurated and on those under consideration. As these projects are of common interest it can scarcely be expected that a

certain set of resolutions adopted before the close of the war will furnish a final solution of these difficulties, notwithstanding the eminence of those directly concerned in drafting or in adopting the resolutions.

The great scientific progress since the Middle Ages has been largely due to the separation, mental or statutory, of concepts or institutions of fundamental human interests. As instances, we may refer to the separation of church and state, of knowledge and superstition. It would seem very unfortunate if we should now allow moral and ethical questions to becloud our vision as regards scientific merits or demerits. We all welcome exposures of unfair scientific dealings practised persistently by such large numbers as to constitute national characteristics, but if these exposures are to be really effective they should bear evidence of the fact that the accused had a fair chance to defend themselves. Hence the need of open international scientific conferences seems to be greater now than before the war.

G. A. Miller

QUOTATIONS

A NATIONAL LABORATORY FOR THE STUDY OF NUTRITION

A resolution of the Inter-Allied Scientific Food Commission, which does not appear to have attracted as much notice as it deserves, dealt with the need of establishing national laboratories for the study of human nutrition. The commission pointed out that, as at least one quarter of the whole income of a nation was devoted to the purchase of food by its individual citizens, it was a matter of the highest importance for the welfare and prosperity of a country that the methods of utilizing its food resources in the best way should be explored and definitely established on the basis of scientific data. The commission therefore adopted a resolution urging the allied governments to establish national laboratories to be devoted to the task. There is no doubt that the want of such a laboratory will be especially felt in the United Kingdom, where the husbanding of our food resources is likely to remain imperative longer than in countries which are normally nearly self-supporting.

The contrast between the extent to which the study of human metabolism has been fostered by the state or left to private enterprise in England and the United States is little to the credit of our rulers. Nor can it be pleaded in extenuation of the neglect that English men of science have shown no signs of being attracted by the problems of nutrition and metabolism. On the contrary, without any depreciation of the labors of such Americans as Atwater and Benedict, or such Germans as Rubner, we can justly claim that the present generation of English physiologists has made contributions to the science of nutrition equal in value to anything which has been achieved elsewhere. We need merely cite the brilliant researches into the chemical mechanisms of digestion which we owe to Starling and Bayliss, the work of Hopkins and his pupils on protein metabolism, and the succession of important contributions to the study of deficiency diseases which have come from the laboratories of the Lister Institute, culminating in the recent work of Dr. Chick and her collaborators.

Since the war the Royal Society, by the agency of its food (war) committee, has, with little official aid and, at times, in spite of official indifference or neglect, done much to bring the subject of national dietetics under proper scientific guidance, but we are of opinion that its work will not be extended and made of permanent value to the nation unless effect is given to the Inter-Allied Commission's proposal.

We shall endeavor to make the reason plain by considering one only of the topics within the scope of nutritional research. The Inter-Allied Commission mentioned the need of determining the amount of food required to maintain the health and strength of persons engaged in different occupations. As we had to point out some time since, when the policy of the food controller received less inspiration from scientific sources than has happily been the case during the past twelve months, the broad distinctions between class and class, the

general laws of human energetics, have been long established. But details which are of great importance when any exact view of the subject is desired, still escape us. To express the energy requirements of agricultural laborers in terms of food with the precision attainable by an actuary in estimating their average expectation of life is still an ideal of the remote future. This is only in part due to the greater difficulty of measuring energy transformations as compared with the measurement of longevity. It is now quite possible by means of relatively simple apparatus to carry out such determinations on a large scale. But the task is not one that any private investigators can be expected to undertake. The mere compilation of statistics of family consumption, a less laborious affair, occupied much of the time of the United States food investigators for years. Here is a proper object for the team work of which so much is heard in these times. It involves physiological skill both in making the measurements themselves and in paying due heed to the attendant circumstances, such as the cooling power of the air in the factory or workshop, a point scarcely heeded by many past students; industrial knowledge is needed to decide what factory processes are *in pari materia* so that representative samples may be chosen for experiment; lastly, some experience in the handling of numerical data is required to decide the significance of departures from the average and the limits of precision of the averages themselves. Nor does it suffice to enroll a suitable team of investigators and send them out into the factories to collect data. The routine application of a physiological technique is the death of science. When a method is intelligently applied upon a large scale anomalous results must emerge, the analysis of which upon a laboratory scale and with the attendant simplification of the conditions may lead to the discovery of new and important truths. The investigating staff must be attached to a headquarters laboratory controlled by a physiologist competent to sift real anomalies from mere technical errors and to cause them to be sedulously investigated. We conceive that in this way alone a really adequate knowledge of the energy requirements of muscular work can be attained.

When it is remembered that this problem, important as it is, is only one of the problems of human nutrition which are still unsolved, we do not think more need be said in support of a national laboratory of nutrition. No doubt the time will come when the intelligent citizen will find it difficult to understand how any nation could neglect to make such a provision for its literally vital needs.—*British Medical Journal*.

SCIENTIFIC BOOKS

An Outline of the History of Phytopathology. By Herbert Hice Whetzel. Philadelphia and London, W. B. Saunders Company. 1918. Pp. 130, with 22 portraits.

The domain of plant pathology is rapidly taking shape as a highly important part of the contribution of botany to the economic life of the world, as well as a department of botanical science demanding recognition from students of the modern aspects of science in general. The enormous losses which crops suffer from parasitic and predatory fungi have long been recognized in a general way, but only in recent years, since numerous investigators have undertaken to study the causes which inhibit the optimum development of cultivated plants, has the great diversity in the etiology of plant diseases been so clearly shown. With the recognition of the diseases and their causes has grown up practical means for controlling or avoiding many of them. The economic returns have reacted upon the opportunities for investigation, and consequently great progress has been made in this department of botany within the few decades just past, more especially in America. The epidemic of the chestnut blight, the fight against the white pine blister-rust, the barberry-wheat campaign, and the government and state quarantine acts against the importation of diseased plants, have brought the subject home to every one.

The pioneer work by Professor H. H. Whetzel, of Cornell University, on the history of

phytopathology is therefore a timely and serviceable contribution. The subject is treated by Professor Whetzel in an attractive and perspicuous manner, and covers from the most ancient times to the present. Both the development of concepts regarding the nature and treatment of diseases as well as the dominating influence of phytopathological writers are taken into consideration in dividing the time into eras, and again into periods.

Scarcely thirty pages are given to the three incubation eras, called the Ancient, Dark and Premodern Eras, but they are most readable pages, and clearly point out the course of the early development of the subject.

The Modern Era, extending from 1853 to 1906, was one of great activity in all scientific lines. During this time phytopathology became a distinctive science. Many investigators of forceful personality and marked ability gave direction to the work of discovery, and in consequence the boundary of knowledge in the field of plant diseases was enormously extended. The center of pathological activity in its academic aspects was at first in Germany, and in its practical and commercial aspects in France, but in both aspects the foremost advance began to shift to America in the eighties, and soon this country became the leader in initiative as well as in the amount of investigation.

The present era, now just entering its second decade, has seen the establishment of chairs of phytopathology in many universities, the rise of the American Phytopathological Society and of the journal *Phytopathology,* the enactment of effective quarantine measures against the international and interstate movement of diseased plants, a new class of fungicides with sulphur in place of copper, the discovery of the canceroid nature of crown gall, and in general the recognition by men of affairs as well as by the cultivator of the vast importance of the utmost detailed information regarding plant diseases and of cooperative and efficient means for making such knowledge available in protecting all sorts of crops and plant life.

This orderly presentation of the evolution of a science destined to play an increasingly wider and more important part in the affairs of human well-being and achievement is particularly timely. Professor Whetzel has compressed into the hundred and thirty pages of his book a well balanced and helpful outline of the historical aspects of the science. It is a valuable addition to botanical literature.

J. C. ARTHUR

PURDUE UNIVERSITY

SPECIAL ARTICLES

RESISTANCE IN THE AMERICAN CHESTNUT TO THE BARK DISEASE

DURING the past summer, in connection with the Office of Forest Pathology, U. S. Department of Agriculture, the writer investigated conditions in the American chestnut looking toward immunity or disease resistance to the well-known bark disease. A thorough search was carried on, which, for obvious reasons, was restricted mainly to the immediate neighborhood of New York City. The results are deemed of sufficient importance to warrant publication here in advance of a more detailed account.

No immune trees were found, but a considerable number of resistant trees were located, some of them on the island of Manhattan itself. The following points are considered evidence of a resistant quality in these trees.

1. The result of inoculation tests. The average lateral growth of the fungus in 289 inoculations was 0.6 cm. for a period of from 5 to 6 weeks—mainly in August. This is about one fourth the figure (2.2 cm.) given by Anderson and Rankin for normal trees during the month of August at Napanoch, New York, and about one fifth the figure (2.83 cm.) given for the same month by the same investigators at Charter Oak, Pennsylvania.[1]

2. The occurrence of the trees in a neighborhood long subject to the disease, and the presence among the trees of individuals long since dead.

1 Anderson, P. J., and Rankin, W. H., "Endothia Canker of Chestnut," Cornell Univ. Agric. Expt. Sta. Bull. 347, pp. 574, 575, 1914.

3. Evidence of the long period the disease has been present in the trees themselves; *i. e.*, bare, weathered tops; *healed* cankers; thrifty branches, with bases diseased and hypertrophied, but living, etc.

4. Peculiarities of the bark; such as extensive development of a callus tissue, and the presence of a peculiar substance which is constantly associated with, and particularly conspicuous in cases of marked resistance.

5. The natural grouping of the trees in well-defined areas or "pockets," pointing to a genetic variation.

6. The manifestation by members of the same coppice group; and by branches, trunk and basal shoots of the same individual; of similar degrees of resistance, indicating an inherent condition.

If these facts and inferences are correct, they point the way clearly toward a reconstruction and a revival of our American chestnut. Many of the trees bloomed well, and this fall bore good fruit. A large number of nuts have been gathered and planted by Dr. Van Fleet, of the U. S. Department of Agriculture, at the trail grounds near Washington, D. C. If the resulting seedlings substantiate the inference that the disease resistance is a heritable character, the way lies open, both by inbreeding, and by crossing with the resistant oriental species (not good timber trees themselves) to develop an extremely resistant or perhaps practically immune strain of timber tree for the reforestation of our devastated chestnut woodlands.

ARTHUR HARMOUNT GRAVES
OFFICE OF INVESTIGATIONS IN FOREST PATHOLOGY,
BUREAU OF PLANT INDUSTRY,
WASHINGTON, D. C.

THE OCCURRENCE OF AZOTOBACTER IN CRANBERRY SOILS

SEVERAL papers have appeared recently in SCIENCE and elsewhere[1, 2] concerning the fact that the aerobic non-symbiotic nitrogen fixing organisms, namely the *Azotobacter* group, occur in the soil, when the concentration of the hydrogen-ion is not more than 10^{-6}, or the limiting exponent is 6.0.

Investigators[3] have gone so far as to use the presence of *Azotobacter* in the soil as an indication of the soil reaction. Gillespie,[2] interpreting the results of Christensen,[3] stated that they are in accord with those obtained by Gainey,[1] namely the limiting hydrogen-ion exponent for the presence of *Azotobacter* in the soil is 6.0.

The methods previously used in determining the soil acidity conveyed only a very indefinite idea about the true nature of the reaction of the soil. But only recently [4, 5] methods have been suggested which, either using the electrometric or an improved colorimetric method, have enabled us to get a better insight into the extent and nature of soil acidity. These studies have brought out the facts referred to above concerning the reaction limit for the existence of *Azotobacter* in the soil.

In the study of the microbial population of cranberry soils some interesting observations were made and of these only the occurence of *Azotobacter* will be reported here.

The cranberry soils are so distinctly different from ordinary soils that it was thought for a long time that no very large number of bacteria can exist in them and that the microbial population consists predominantly of molds. These soils are known to have a distinctly acid reaction and contain large quantities of undecomposed organic matter, namely the roots and the stubble of the dead plants. The existence of *Azotobacter* in cranberry soils would be of great practical importance, since the nitrogen of the air would thus be fixed and made available to the crops, which have to grow in soils rather poor in available nitrogenous constituents (particularly is this true of sandy bottom bogs). The undecomposed roots and stubble would supply the carbohydrates necessary for the activities of *Azoto-*

1 Gainey, SCIENCE, Vol. 48, pp. 139–140, 1918; *Jour. Agr. Res.*, Vol. 14, pp. 265–271, 1918.

2 Gillespie, SCIENCE, Vol. 48, pp. 393–394, 1918.

3 Christensen, *Soil Science*, Vol. 4, pp. 115–178, 1917.

4 Gillespie, *Jour. Wash. Acad. Sci.*, Vol. 6, pp. 7–16, 1916.

5 Sharp and Hoagland, *Jour. Agr. Res.*, Vol. 7, pp. 123–145, 1916.

bacter, particularly in the presence of cellulose decomposing organisms.

The high acidity of the cranberry soils would preclude the very idea of finding the *Azobacter* in these soils and the early students[6] of this group of organisms were of the opinion that they can not live in acid media at all but the reaction has to be adjusted first to neutrality before the conditions are made favorable for their activities.

A Savannah bottom cranberry bog situated at Whitesbog, N. J., was used for this work. A part of the bog was limed three years ago and the crop was almost double of the corresponding plot, unlimed. Samples of the soil from the two plots were secured under sterile conditions and used for this study. The soil is nothing more than some white sand interwoven with decayed and living plant residues.

The hydrogen-ion concentration of the two soils was determined by means of the colorimetric method, using the phenol-sulfon-phthalein indicators suggested by Clark and Lubs.[7] The method corresponds very closely with the electrometric determinations using the hydrogen electrode, as was shown by Gillespie.[2] A definite amount of soil was shaken with double its weight of distilled water, then centrifuged; the supernatant clear liquid was syphoned off and used for the determination of the hydrogen-ion concentration. The unlimed soil had an hydrogen-ion concentration of pH = 5.4 to 5.6 while for the limed soil pH was 6.2—6.4.

The two soils were added in 10-gram quantities to 100 cc.c. portions of a sterile faintly alkaline nitrogen-free mannite solution and incubated at 25°. The solution in the flasks containing the limed soils became turbid in four days and a pellicle characteristic of *Azotobacter* began to develop in some flasks. On microscopic examination the solution was found to contain an abundance of *Azotobacter* cells and *Actinomyces* filaments. The solution in all the flasks to which the unlimed soil was added remained clear as in the control, but has shown a profuse gas production. On microscopic examination no *Azotobacter* cells and no *Actinomyces* filaments were discovered.

The limiting reaction for the existence of *Azotobacter* in the soil, expressed in the hydrogen-ion concentration is thus found to fall between pH—5.4 to 5.6 and pH—6.2 to 6.4 and is probably nearer the latter. This will confirm the results of Gainey[1] and Christensen[3] that an hydrogen-ion concentration of the soil = pH—6.0 is the limiting reaction for the activities of *Azotobacter* in the soil.

The occurrence of *Antinomyces* filaments together with *Azotobacter* cells suggests a still more interesting and important possibility, association between these two groups of soil microorganisms. As will be soon shown elsewhere many *Actinomyces* decompose organic residues very rapidly. The association between these two groups of organisms, change of reaction, and the action of *Actinomyces* upon the nitrogen-fixation by *Azotobacter* is being studied at present in this laboratory.

The importance of *Azotobacter* in cranberry soils, which can be effected by changing the reaction of those soils, thus becomes apparent: these organisms, whether alone or in association with others, utilize the plant residues as a source of energy and this allows them to fix the atmospheric nitrogen and increase its supply in the soil, which goes towards an increased crop production.

SELMAN A. WAKSMAN
N. J. AGR. EXP. STATION,
NEW BRUNSWICK, N. J.,
November 2, 1918

[6] Lipman, *Ann. Rept. N. J. Agr. Exp. Sta.*, pp. 262–268, 1904.

[7] *Jour. Bact.*, Vol. 2, Nos. 1, 2, 3, 1917.

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